# The Post-Impoundment Commercial Whitefish Fishery of Southern Indian Lake, Manitoba: Summer 1980 and 1981 Results

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February 1983

**Canadian Manuscript Report of Fisheries & Aquatic Sciences No. 1686**

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Canadian Manuscript Report of
Fisheries and Aquatic Sciences 1686

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This is the 37th Manuscript Report
from the Western Region, Winnipeg

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Cat. no. Fs 97-4/1686 ISSN 0706-6473

Correct citation for this publication is:

Bodaly, R.A., T.W.D. Johnson, and R.J.P. Fudge. 1983. The post-impoundment commercial whitefish fishery of Southern Indian Lake, Manitoba: Summer 1980 and 1981 results. Can. Manuscr. Rep. Fish. Aquat. Sci. 1686: iv + 14 p.

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## ABSTRACT

Bodaly, R.A., T.W.D. Johnson, and R.J.P. Fudge. 1983. The post-impoundment commercial whitefish fishery of Southern Indian Lake, Manitoba: Summer 1980 and 1981 results. Can. Manuscr. Rep. Fish. Aquat. Sci. 1686: iv + 14 p.

The results of this study extend the period of detailed observation of the post-impoundment summer commercial whitefish (Coregonus clupeaformis (Mitchill)) fishery on Southern Indian Lake and confirm the existence of severe declines in catch per unit of effort (CPE) and market quality of the catch. Mean whitefish CPE on traditional fishing grounds decreased from 23 kg/net/night in 1972, prior to impoundment, to 14 kg/net/night in 1979, and this study documents further declines to 10.5 and 7.5 kg/net/night in 1980 and 1981. As a result of these lower catches on traditional fishing grounds, a large proportion of fishing effort was relocated away from traditional areas to the area north of Sand Point. This effort comprised 30 and 33% of the total sampled effort in 1980 and 1981. Fishing north of Sand Point was attractive to fishermen because of 17-26% higher whitefish CPE, shorter wind fetches and shallower fishing depths than on traditional fishing grounds. Whitefish caught north of Sand Point were of lower commercial value than fish from traditional fishing areas because of darker external coloration and higher Triaenophorus cyst counts. Dark whitefish, which were largely absent from the commercial catch prior to impoundment, comprised 12-72% of production from 1976 to 1979 and 34 and 81% in 1980 and 1981. The lake was reclassified to Continental (#2) grade from Export (#1) grade in the summer of 1981 because average Triaenophorus cyst counts from sampled commercial shipments continued to be above the Export limit of 40 cysts/45 kg in 1980 and 1981.



Key words: whitefish, lake; fisheries; freshwater fish; commercial grade, reservoirs (water); impoundment; river diversion; Triaenophorus.



## RESUME

Bodaly, R.A., T.W.D. Johnson, and R.J.P. Fudge. 1983. The post-impoundment commercial whitefish fishery of Southern Indian Lake, Manitoba: Summer 1980 and 1981 results. Can. Manuscr. Rep. Fish. Aquat. Sci. 1686: iv + 14 p.

La présente étude fait suite à la période d'observations détaillées de la pêche commerciale d'été du grand corégone (Coregonus clupeaformis (Mitchill)) dans le Southern Indian Lake aprés sa transformation en réservoir. Elle confirme des déclins importants touchant l'importance des prises par effort de pêche (PEF) et la qualité des prises. Les PEF moyennes de grands corégones dans les aires de pêche traditionnelles sont passées de 23 kg par filet par nuit en 1979 et la présente étude a permis de noter un déclin à 10,5 et 7,5 kg par filet/nuit en 1980 et 1981. Cette diminution des prises dans les aires traditionnelles a eu pour effet de déplacer une partie importante de l'effort de pêche dans la région située au nord de Sand Point. Cet effort représentait 30 et 33% de l'effort de pêche total en 1980 et 1981. La pêche au nord de Sand Point paraissait intéressante, car elle permettait d'accroître les PEF de grands corégones dans une proportion de 17 à 26% tout en s'effectuant dans des zones mieux protégées des vents et à des profondeurs moins importantes comparativement aux aires traditionnelles. Les grands corégones capturés au nord de Sand Point présentaient cependant une valeur commerciale moindre à cause de leur coloration plus foncée et d'une numérotation élevée de Triaenophorus enkystés. Les poissons foncés, généralement absents des prises commerciales d'avant la création du réservoir de retenue, représentaient entre 12 et 72% des prises effectuées de 1976 à 1979 et, respectivement, 34% et 81% des prises de 1980 et 1981. La qualité des prises est passée de la catégorie #1 (Export) à la catégorie #2 (Continental) au cours de l'été de 1981 parce que le dénombrement des kystes de Triaenophorus dans des échantillons commerciaux est demeuré plus élevé, en 1980 et 1981, que la valeur maximale permise de 40 kystes par 45 kg pour la catégorie Export.



Mots-clés: grand corégone; pêche commerciale, poisson d'eau douce; catégorie commerciale; réservoirs (d'eau), barrage de retenue; dérivation de cours d'eau; Triaenophorus.

## INTRODUCTION

Significant changes in the catch and grade of the Southern Indian Lake commercial whitefish (Coregonus clupeaformis) fishery since impoundment and Churchill River diversion in 1976 have been previously documented (Bodaly et al. 1980b; MacLaren 1978). Bodaly et al. (1980b) and MacLaren (1978) noted that the pre-impoundment catch was composed almost entirely of export (#1) quality whitefish and that this catch was maintained by selective exploitation of certain lake basins. Catch per unit effort (CPE) on traditional fishing grounds in the 1979 summer fishery was only 60% of pre-impoundment CPE and fishermen responded with a significant geographic shift in fishing effort to areas formerly avoided (Bodaly et al. 1980b). The post-impoundment catch over the period 1977-1979 was composed of from 12 to 72% of darker colored, lower quality whitefish which were more highly infested with muscle cysts of the parasite Triaenophorus crassus (Bodaly et al. 1980b; MacLaren 1978).

It is the purpose of this study to confirm the extent of changes previously reported by presenting a further two years data, to determine if definite trends have occurred in the fishery with regard to catch and grade since the 1979 study, and to provide data to assist in the development of compensation plans and agreements.

## MATERIALS AND METHODS

### STUDY AREA

Southern Indian Lake (SIL) is located in north-central Manitoba (57°N, 99°W) on the Churchill River. SIL was the 21st largest lake in Canada, with a pre-flooding surface area of 1,977 $km^2$ (McCullough 1981). The natural flow of the Churchill River entered SIL in the southwest extremity and exited as Missi Falls, off the northern lake basin (Fig. 1). A control structure was constructed at Missi Falls and 85% of the flow of the Churchill River was diverted to the Nelson River via an artificial channel (Fig. 1). Regulation and impoundment was initiated in the summer of 1976 and the lake level was raised 3 m above the mean level of 255 m MSL to 258 m MSL with a regulated range of 1 m. The post-flooding mean depth is 10 m, while pre-flooding mean depth was 9 m (McCullough 1981).

Commercial fishing on Southern Indian Lake began in the winter season of 1941-1942. Summer commercial fishing began in 1950. The fishery has been substantial for a number of decades and is presently the largest whitefish fishery in northern Manitoba. The mean annual commerial whitefish catch (5 yr averages) has ranged from 362,000 to 482,000 kg over the period 1957-1981. Whitefish make up ~80-85% of the total landed catch with walleye (Stizostedion vitreum) and northern pike (Esox lucius) comprising most of the remainder. During the 1970's, the summer season accounted for approximately 85% of the total fishery poundage.

### DATA COLLECTION

Fishing locations and number of nets set were determined by dockside and net site interviews with commercial fishermen. Interviews were conducted at the Loon Narrows packing plant (Fig. 1) and on the lake in the area north of Long Point in June, July and August of 1980 and 1981. Approximately 80-85% of landings for Southern Indian Lake were made at the Loon Narrows plant. Fishermen were asked for fishing location(s), number of nets set in each location, and the number of nights that nets had been left set since last emptying or setting. The weight and grade of lake whitefish for each delivery was recorded from Freshwater Fish Marketing Corporation (FFMC) daily catch records produced at Loon Narrows and fishermen's weekly fish purchase tickets produced by FFMC, Winnipeg. Data was recorded by fishing enterprise or skiff, whether an enterprise comprised two or more licensed fishermen or a licensed fisherman plus helper(s). All fishing enterprises landing fish at Loon Narrows during the particular hours and days that the interview team were on site and all fishing enterprises encountered on the lake by the interview team while it was performing other duties, were interviewed. Refusals to be interviewed were rare, and thus sampling bias was probably small. Approximately 15% of the total lake-wide whitefish fishing effort (calculated by dividing the total lake catch by an estimate of overall catch per unit of effort) was sampled by the interview teams in 1980 and in 1981. One fishing period (usually one day) of one fishing enterprise, for which information on the day of net setting, number of nets set, day of net lifting and catch were available, was used as a single data point for the calculation of catch per unit of effort and other parameters.

A standard gill net of 13.3 cm (5 1/4 in) stretched mesh and 91.4 m (100 yd) in length was used in the lake whitefish fishery. The use of 10.8 cm (4 1/4 in) stretched mesh was limited to restricted areas, primarily in the north-east extremity of the lake, and comprised less than 10% of the effort in that area.

The age distribution of the commercial whitefish catch from traditional fishing areas was estimated by sampling fish at random from catches over the course of the fishing season in 1979, 1980 and 1981. A sample of fish from the 1979 catch was aged from scales to compare to ages obtained for the 1972 pre-impoundment catch reported by Weagle and Baxter (1973). Scales were taken from between the dorsal fin and the lateral line. The sample of scales taken in 1979 was aged after the reader had achieved 80% consistency reading a subsample of the 1972 scales. Fish were aged from pelvic fin ray sections in 1979, 1980 and 1981. Fin rays were prepared following Mills and Beamish (1981) and aged by the same persons in all three years.

## RESULTS

### GEOGRAPHIC DISTRIBUTION OF FISHING EFFORT

In 1980 and 1981, a significant proportion of fishing effort was located north of Sand Point, outside of traditional fishing grounds (Fig. 2 and 3). In 1980, 30% (1496 net nights) of the total sampled effort of 5,059 net nights was expended north of Sand Point, while in 1981, 33% (1,780 net nights) of the total sampled effort of 5,356 net nights was expended north of Sand Point.

### CATCH PER UNIT OF EFFORT

Lake whitefish catch per unit of effort (CPE) for fishing enterprises landing fish at Loon Narrows packing plant in 1980 averaged 11.6 kg/net/night. The mean CPE for the area south of Sand Point was 10.5 kg/net/night. Lake whitefish CPE in 1981 averaged 7.9 kg/net/night. The mean CPE for the area south of Sand Point was 7.5 kg/net/night while the mean CPE for the area north of Sand Point was 8.9 kg/net/night (Fig. 5).

Whitefish CPE on traditional fishing grounds has decreased significantly since 1979. One way analysis of variance on $\log_{10}$ transformed observations showed that a significant difference in mean CPE existed between the years 1979, 1980 and 1981 ($F_{2,479} = 41.0$; $p < 0.001$).

### FREQUENCY OF NET RELOCATION

Nets were set in one location in 1980 for an average of 9.5 days. The frequency of net relocation differed considerably for areas north and south of Sand Point. Nets were left in one location for an average of 14 days (range 1-18) north of Sand Point but for an average of only 5 days (range 1-13) south of Sand Point.

In 1981, nets were left in one location for an average of 5.8 days (range 1-25) before relocation. The frequency of net relocation was quite similar for areas north and south of Sand Point. Nets were left in a particular location for an average of 5.9 days (range 1-25) south of Sand Point and for an average of 5.6 days (range 2-12) north of Sand Point.

### NUMBER OF NETS FISHED BY COMMERCIAL ENTERPRISES

In 1980, fishing enterprises fished an average of 18.1 nets at a given time (range 2-48; s.d. 7.78). In 1981, an average of 19.2 nets were fished (range 2-47; s.d. 7.01)

### GEOGRAPHIC DISTRIBUTION OF LIGHT AND DARK LAKE WHITEFISH

In 1980, light colored lake whitefish were generally restricted to catches from south of Sand Point (Fig. 6). Catches from north of Sand Point were usually composed totally of dark colored whitefish. There were some concentrations of dark colored whitefish in shallow areas near shore in waters south of Sand Point and mixed catches of light and dark colored whitefish near Sand Point (Fig. 6).

In 1981, there was an apparent increase in the proportion of dark colored whitefish south of Sand Point. There were high concentrations of dark whitefish near shore, as well as in areas several km from shore. The area near Sand Point produced catches almost entirely composed of dark colored whitefish (Fig. 7).

### MARKET QUALITY OF THE CATCH

The total lake whitefish production in summer 1980 was 387,900 kg (round equivalent weight) (FFMC data). In the summer of 1980, catches were separated into light and dark whitefish and shipments of lights were usually graded as Export (#1) while shipments of the darks were usually graded as Continental (#2). Of the total summer 1980 production, 65% by weight were light Export fish while 35% were dark Continental grade fish. The total lake whitefish production in summer 1981 was 288,900 kg (round equivalent weight) (FFMC data). During the first part of the 1981 summer season, grading was conducted as in 1980; however, during the second part of the season the total catch was downgraded and all whitefish were classified as Continental grade regardless of color. Of the total summer 1981 production, 14% by weight were Export grade and 86% were Continental grade.

Prior to impoundment in 1976, average *T. crassus* cyst counts in whitefish shipments sampled by Canada Department of Fisheries inspectors were consistently below 30 cysts per 45 kg dressed weight (Table 1). Since impoundment, mean cyst counts have ranged from 43.5 to 79.1 cysts per 45 kg as compared to the dividing line between Export and Continental grade of 40 cysts per 45 kg. Sampling of commercial shipments is not random but the dramatic changes in mean cyst counts may be taken as an indication of a change in the overall grade of the catch.

### AGE DISTRIBUTION OF THE CATCH

The age distribution of the commercial whitefish catch from traditional fishing areas in 1979 soon after lake impoundment, was very similar to the age distribution in 1972, prior to impoundment (Fig. 8). The mean ages of the samples were almost identical and the age structures of the catches appear very similar.

Over the post-impoundment period 1979-1981, the mean age of the commercial whitefish catch, as determined from fin ray sections, has remained very stable at 9.95-10.40 years (Fig. 9). The modal age in 1979 and 1980 was 11 years while the modal age in 1981 was 10 years. There were significant differences in the age distributions of the catches over the period 1979-1981, as tested by a 3 x 7 contingency table ($X^2_{(12)} = 52.9$; $p < 0.001$). There appeared to be relatively fewer fish of age 11 and relatively more fish of age >11 in 1981 as compared to 1979 and 1980.

## DISCUSSION

This study has documented continuing problems in the market quality and catch of the Southern Indian Lake whitefish fishery. Whitefish CPE on traditional fishing areas declined from 23 kg/net/night before flooding (Weagle and Baxter 1973) to 14 kg/net/night in 1979 (Bodaly et al. 1980b) and this study documents further declines to 10 1/2 and 7 1/2 kg/net/night in 1980 and 1981. Fishermen have responded to these decreases in whitefish CPE by relocating a significant amount of fishing effort to areas north of Sand Point. Prior to flooding, almost no fishing was conducted north of Sand Point (Weagle and Baxter 1973); in 1979, 62% of fishing effort was located north of Sand Point (Bodaly et al. 1980b), and the present study documents that 30 and 33% of fishing effort was expended north of Sand Point in 1980 and 1981.

Fishing in the area north of Sand Point was attractive to commercial fishermen after impoundment primarily because of higher catches than on traditional fishing grounds. Catches north of Sand Point in 1979 were 26% higher than south of Sand Point (Bodaly et al. 1980b) while they were 36 and 16% higher in 1980 and 1981. Also, it was more efficient to fish areas north of Sand Point because nets were easier to set due to shallower water depths and shorter wind fetches than on traditional fishing grounds.

The amount of fishing effort expended north of Sand Point has depended largely on the varying provisions of annual compensation agreements between the Southern Indian Lake Fishermen's Association and the project utility, Manitoba Hydro. In 1979, a relatively small incentive bonus was paid on fish originating from traditional fishing grounds and no time or poundage limitations were agreed upon for fishing production from areas north of Sand Point, the result was that a relatively large proportion of fishing effort was expended north of Sand Point (Bodaly et al. 1980b). In 1980, fishing north of Sand Point was limited to a certain short period of time, and, in 1981, a voluntary poundage quota for this area was agreed to. Therefore, a smaller proportion of the sampled effort in 1980 and 1981 was expended north of Sand Point.

The geographic distribution of light and dark whitefish, coupled with the fact that a significant proportion of fishing effort continues to be expended north of Sand Point, has resulted in continued market quality problems in the whitefish catch. Dark colored whitefish comprised 8, 12, 56 and 72% of the catch in 1976, 1977, 1978 and 1979, whereas they were essentially absent from the catch prior to lake impoundment (MacLaren 1978; Bodaly et al. 1980b) and,in 1980, dark whitefish comprised 35% of the catch. In 1981, the lake was reclassified and 86% of the catch was classified as #2 grade.

In addition to shifts in the geographic distribution of fishing effort, other aspects of traditional fishing procedures have been altered in attempts to maintain whitefish CPE on Southern Indian Lake. Nets were relocated much more frequently and the average time nets were left set at the same site appeared to be related to CPE. Before flooding, nets were left in one location for an average of 18 days (Bodaly et al. 1980b). After flooding, the average time that nets were left in one location on traditional fishing grounds declined to 7 days in 1979 (Bodaly et al. 1980b) and to 5-6 days in 1980 and 1981. Catches north of Sand Point have generally been higher than on traditional fishing grounds and nets were left set in one location for similar or longer periods of time than on traditional fishing grounds. In general, fishermen have attempted to maintain catches by changing locations and depths of net sets from former successful locations and depths. Fishermen preferred to set on reefs and in areas that they believed to be whitefish feeding grounds, where concentrations of rough fish could be avoided. Immediately after impoundment, fishermen found that catches in their traditional locations were very low and rough fish could not be avoided by relocating. Rough fish take considerable time to remove from net gear and may compete for available net space. Other aspects of the post-impoundment fishery which have tended to increase the expense and effort required to maintain catches are increased travel distances to land fish at the Loon Narrows packing plant, increased number of nets being fished, increased time required to clean vegetation debris from nets and increased difficulty of landing on most flooded shorelines.

The decrease in whitefish CPE on traditional fishing grounds has been confirmed by experimental fishing. Bodaly et al. (1980a) found that whitefish CPE in 13.3 cm (5 1/4 in) stretched mesh gill nets decreased from a mean of 4.0 fish/46 m/16 h (range 0-11.8; n = 17) in 1972-1975 prior to impoundment to a mean of 0.7 fish (range 0-3.8; n = 14) in 1978-1979 after impoundment. Also, experimental fishing with commercial fishing gear conducted in 1980 (total effort 1,142 net nights) resulted in a mean whitefish CPE of 9 kg/net/night (Manitoba Hydro, unpubl. data) which is very similar to the estimate reported here for the commercial fishery.

It appears that at least the major portion of the decrease in CPE after impoundment is related to lake impoundment and not fishing effort. The age distribution of the commercial catch was unchanged from 1972 to at least 1980, indicating a lack of excessive fishing pressure. There are some indications of changes in the 1981 age distributions but further data will be required to confirm these changes. Biological parameters of the lakes whitefish population which can serve as indicators of degree of exploitation pressure were examined by Ayles (1976) for pre-impoundment Southern Indian Lake. It was concluded that the populations were showing no signs of overexploitation four years prior to impoundment. There has been a very large increase in the total effort of the fishery since lake impoundment. This increase is evident from the fact that total catch has been generally maintained since lake impoundment but CPE has been reduced by about one-half. Thus, this increased effort coupled with the apparent reduction in stocks due to impoundment could have contributed to the decreases in CPE observed between the period 1979-1981. The 1982 compensation agreement between the South Indian Lake Fishermen's Association and Manitoba Hydro

will provide for decreased quotas on Southern Indian Lake and for fishing of outlying lakes to relieve fishing pressure on the Southern Indian Lake stocks depleted by impoundment.

The immediate post-impoundment declines in whitefish CPE may have been due to stock redistributions between Southern Indian Lake and adjoining water bodies. Whitefish were reported by local fishermen to migrate in and out of Southern Indian Lake via the Missi Falls south channel prior to impoundment. Large concentrations of whitefish were observed below the Missi Falls control dam in 1981, their movement into Southern Indian Lake apparently blocked by the structure. Also, large concentrations of fish have been noted in the South Bay diversion channel. Future research will concentrate on testing this stock redistribution hypothesis.

## ACKNOWLEDGMENTS

We would like to express our thanks to the fishermen and residents of South Indian Lake for their outstanding cooperation and patience with our research programs on the lake. This work would not have been possible without their help. In particular, Noah Soulier was especially helpful. M. W. Wagner and G. Baker assisted in the field. R. Hay, Freshwater Fish Marketing Corporation, The Pas, Manitoba provided unpublished data.

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Table 1. *Triaenophorus* cyst levels in commercial whitefish shipments, summer 1971-1981, Southern Indian Lake, Manitoba (Industry Services Branch, Fisheries and Oceans, Winnipeg, Manitoba).

| Season | Mean no. cysts per 45 kg dressed wt | Range | No. samples | Mean wt of fish per sample (kg) |
|---|---|---|---|---|
| 1971 | 22.6 | 0-81.2 | 59 | 7.8 |
| 1972 | 23.1 | 0-81.2 | 49 | 9.7 |
| 1973 | 29.7 | 0-300.0 | 29 | 8.7 |
| 1974 | | lake not fished | | |
| 1975 | 26.2 | 20.0-37.5 | 6 | 8.9 |
| 1976 | 49.7 | 15.0-206.7 | 14 | 10.7 |
| 1977 | 43.5 | 8.3-234.9 | 40 | 12.0 |
| 1978 | 55.0 | 11.8-190.9 | 10 | 8.9 |
| 1979 | 79.1 | 27.7-320.0 | 7 | 19.5 |
| 1980 | 54.2 | 20.0-127.0 | 36 | 10.5 |
| 1981 | 57.2 | 44.0-75.0 | 11 | 9.0 |

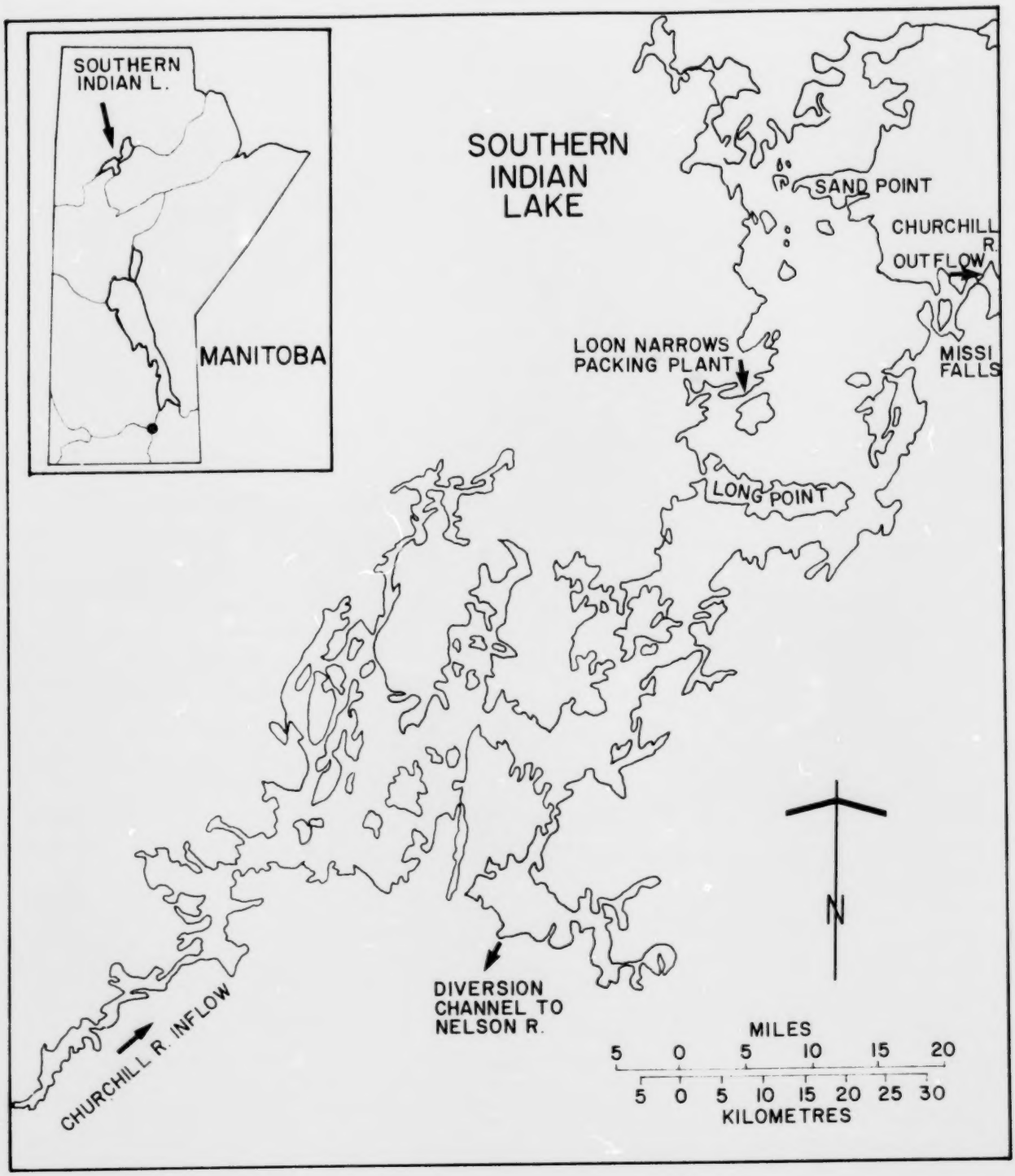


Fig. 1. Map of study area showing Loon Narrows packing plant.

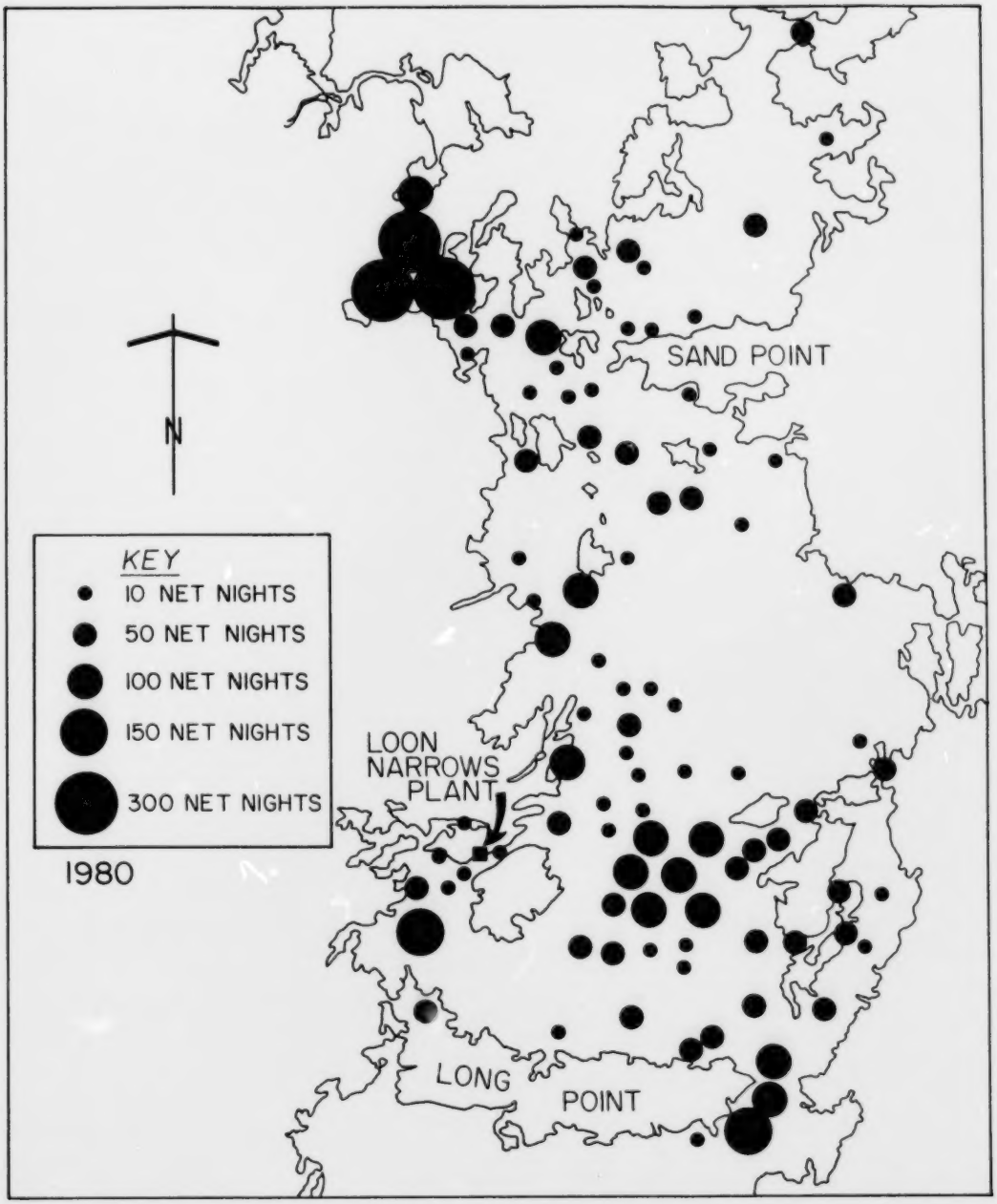


Fig. 2. Distribution of fishing effort (in net nights) north of Long Point, Southern Indian Lake, summer 1980.

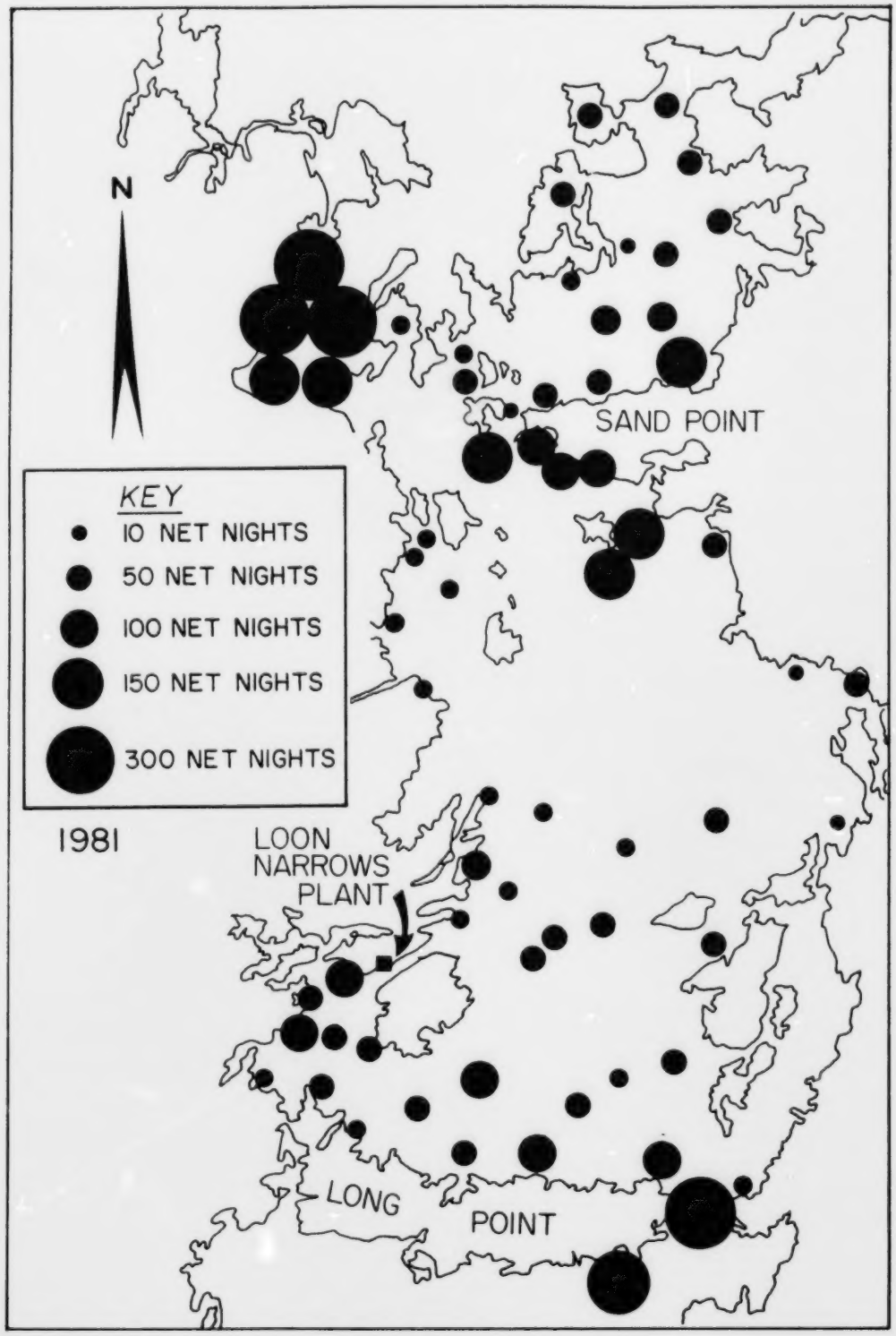


Fig. 3. Distribution of fishing effort (in net nights) north of Long Point Southern Indian Lake, summer 1981.

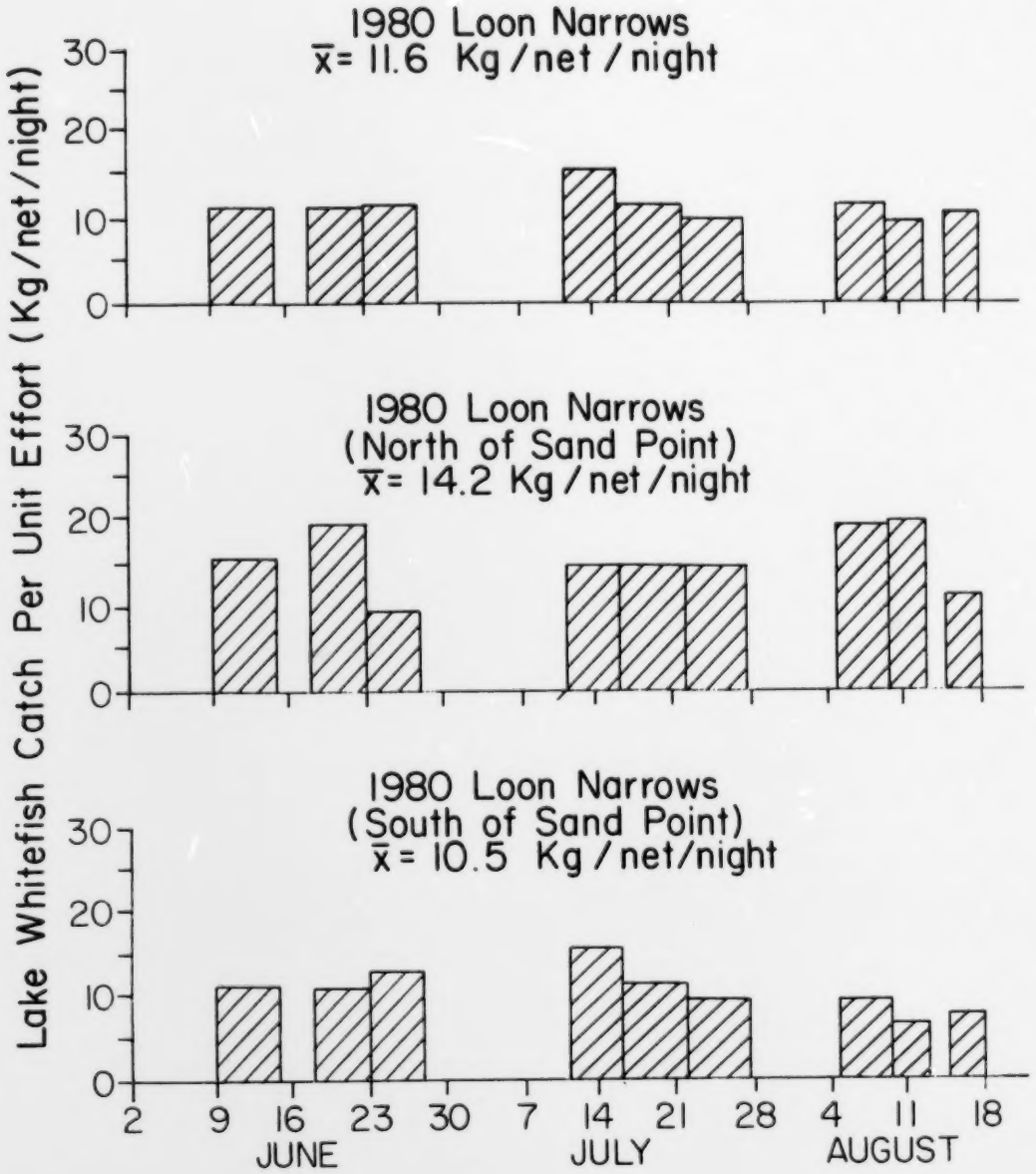


Fig. 4. Lake whitefish catch per unit of effort north of Long Point, Southern Indian Lake, summer 1980.

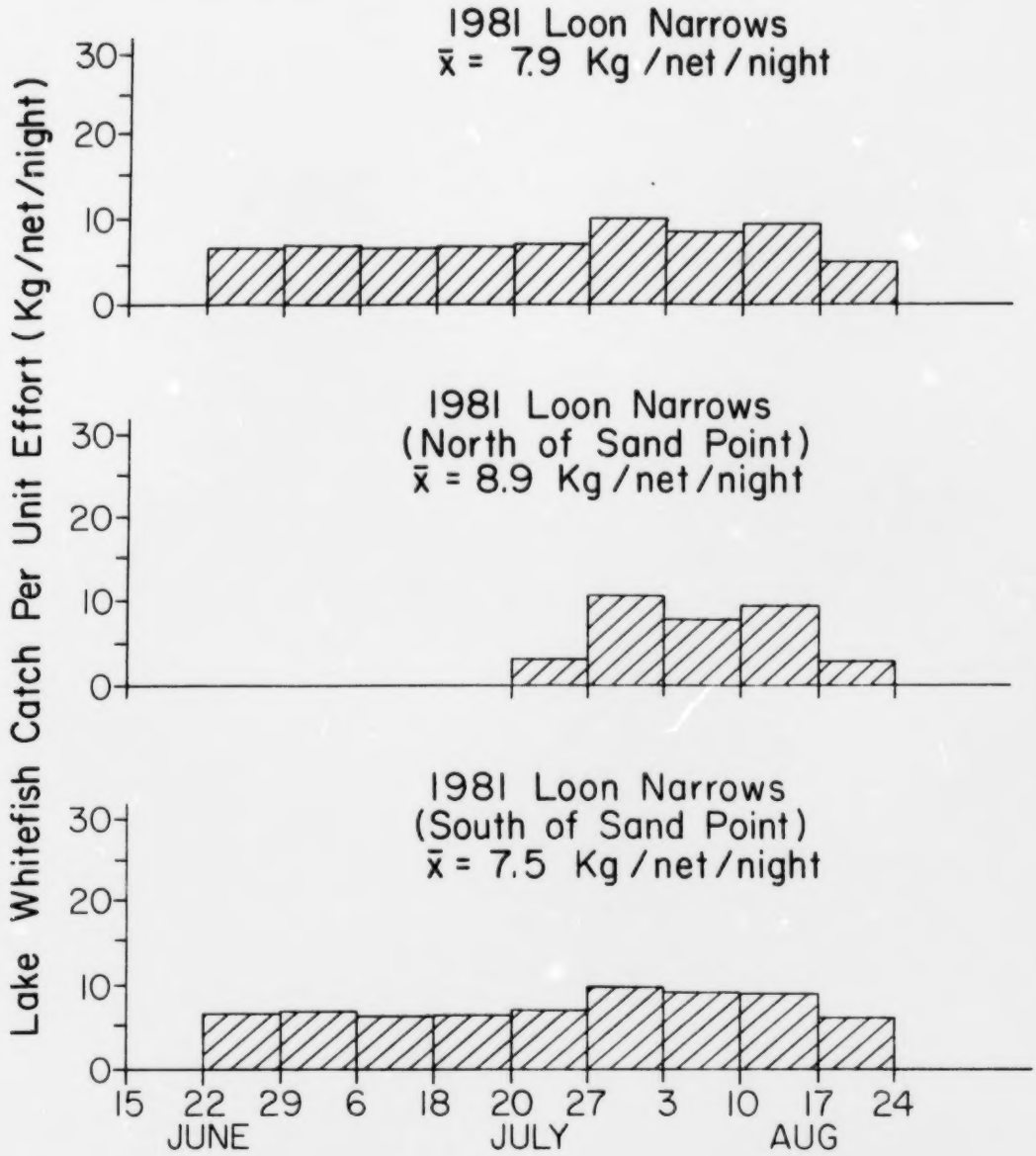


Fig. 5. Lake whitefish catch per unit of effort north of Long Point, Southern Indian Lake, summer 1981.

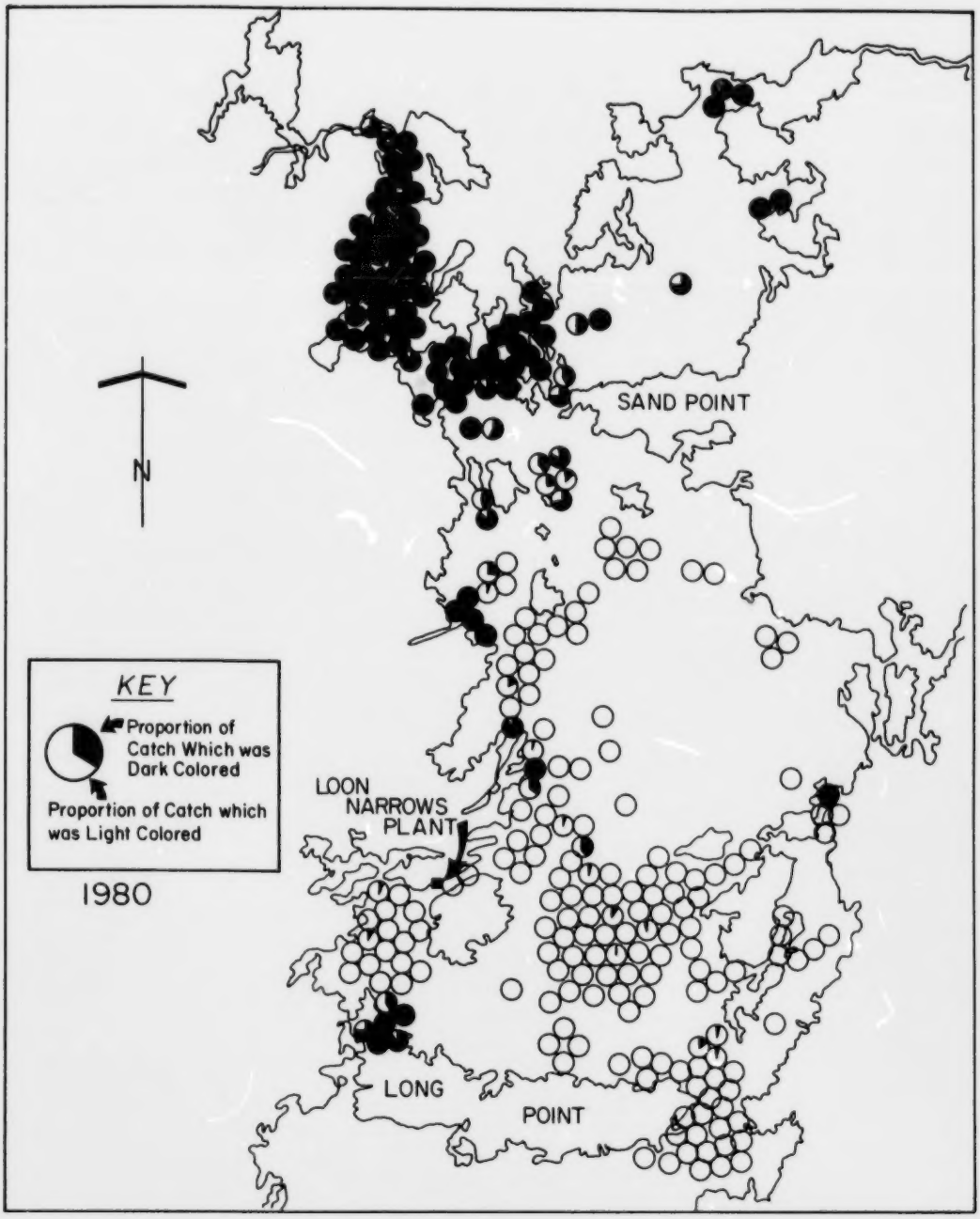


Fig. 6. Geographic distribution of dark and light lake whitefish north of Long Point, Southern Indian Lake, summer 1980.

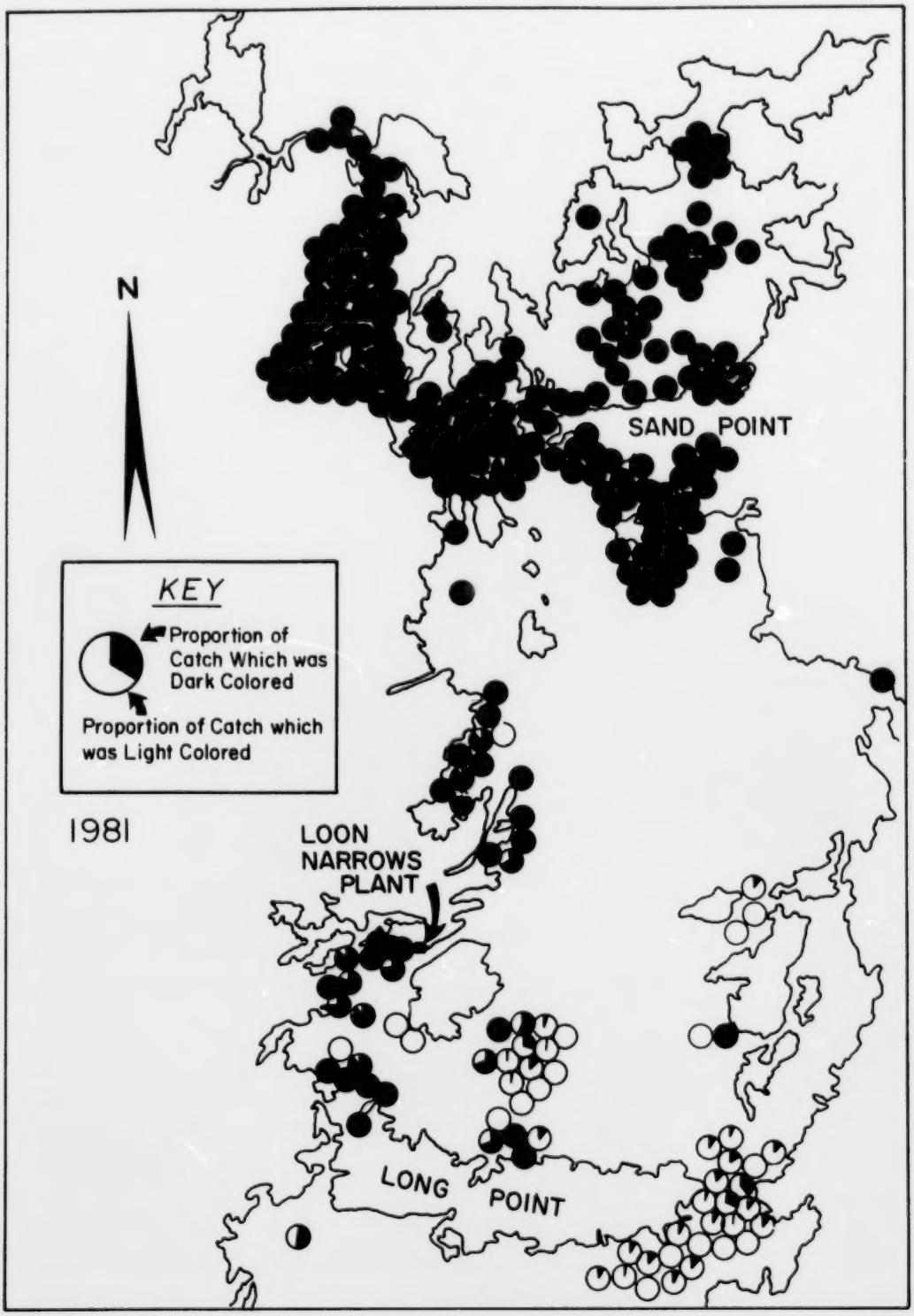


Fig. 7. Geographic distribution of dark and light lake whitefish north of Long Point, Southern Indian Lake, summer 1981.

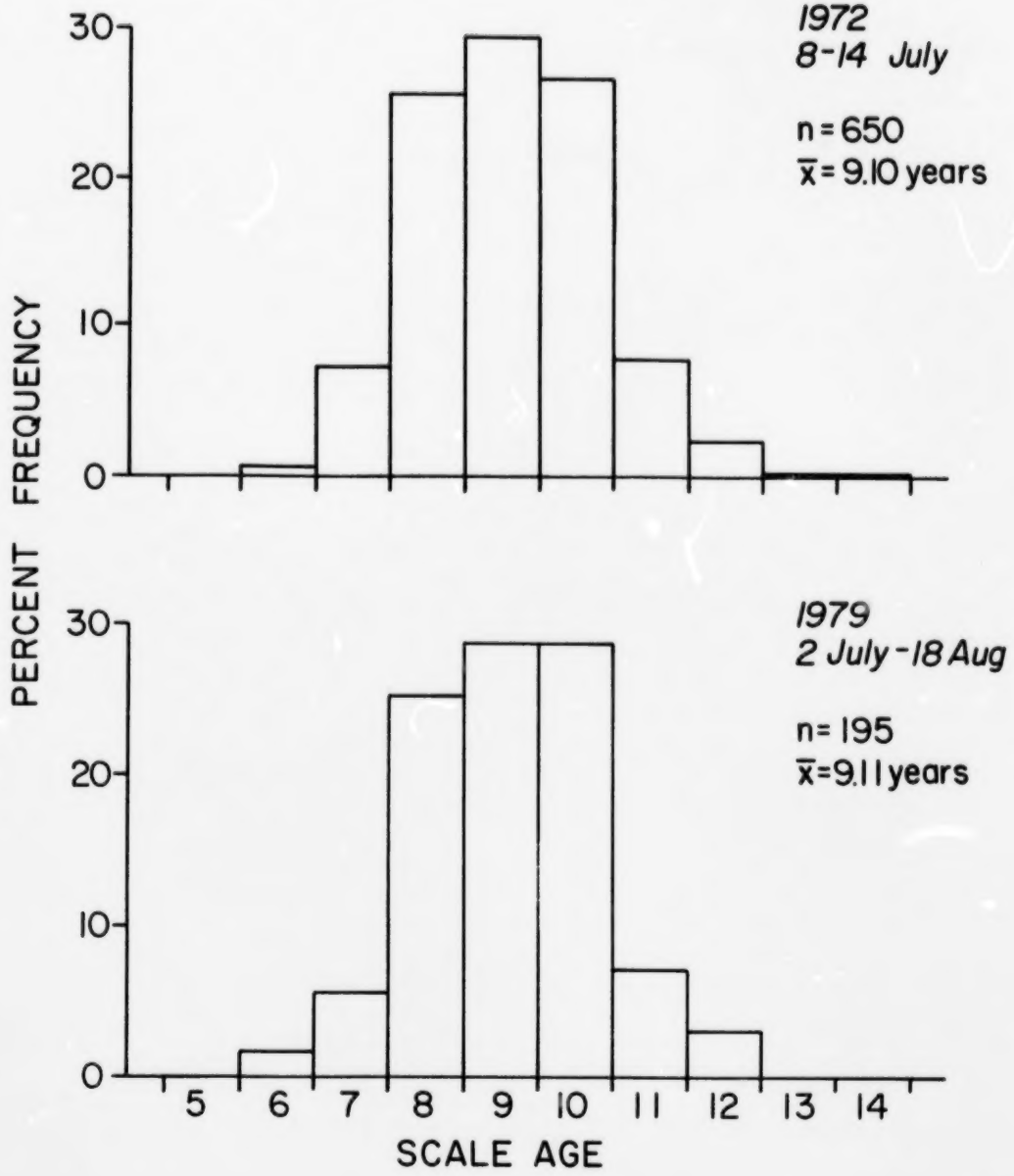


Fig. 8. Pre-impoundment (1972) and post-impoundment (1979) age distributions of commercial whitefish catches from traditional fishing areas (between Long Point and Sand Point). Ages derived from examination of scales.

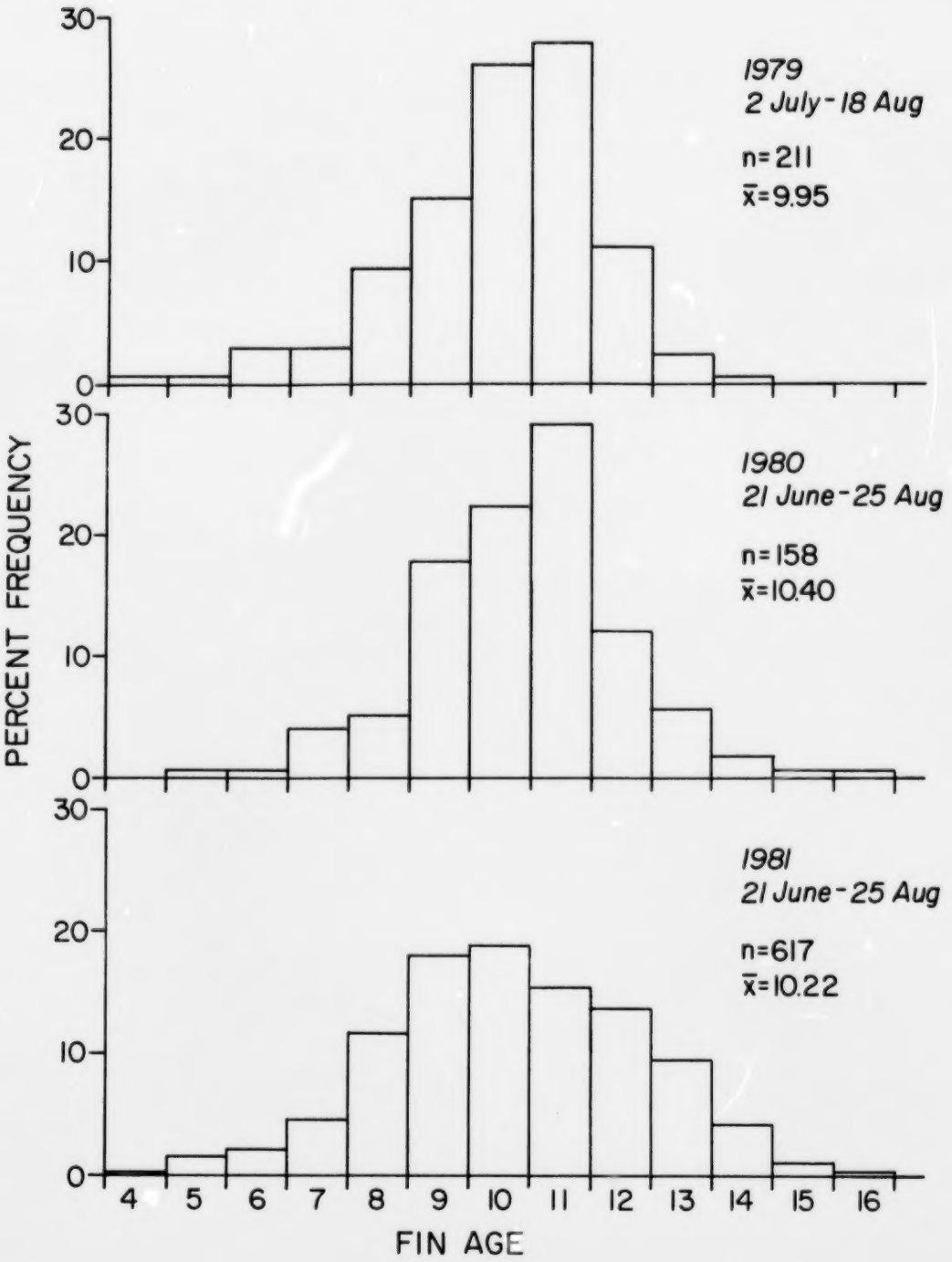


Fig. 9. Post-impoundment age distributions of commercial whitefish catches from traditional fishing areas (between Long Point and Sand Point), 1979, 1980 and 1981. Ages derived from examination of fin ray sections.

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Freshwater Institute
Winnipeg, Manitoba
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